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ABSTRACT

The evaluation of a program designed to encourage minority group high school students to pursue a career in engineering is described. Program goals involved: (1) helping students to acquire an appreciation of the field, learn about requirements for entering an undergraduate program, and strengthen academic skills; (2) encouraging local industry participation; (3) encouraging the active involvement of high school teachers and counselors; (4) facilitating high school groups for future engineers; (5) involving parents; and (6) following project students as they progress through college. Participant activities included visits to several industrial sites and presentations by engineers at the University of Michigan. Some students also participated in a summer program emphasizing mathematics and technical communications skills. Data were drawn from project records, student surveys, and results of a mathematics test and written essay. Although portions of the program's objectives were not met during the first year of operation, many positive outcomes of the program were noted. Success of the summer academic program was indicated by significant increases in the criterion measures. Based upon the data and upon informal discussions and interviews, specific conclusions and recommendations were given. (Author/GDC)

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AN EVALUATION OF THE ENGINEERING INDUSTRIAL SUPPORT PROGRAM FOR 1977-1978

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The judgments, opinions and conclusions expressed in this report are those of the authors and do not necessarily reflect the positions, policies or opinions of the University of Michigan College of Engineering, University of Michigan School of Education or of the Ford Motor Company.

Abstract

An evaluation of the Engineering Industrial Support Program at the University of Michigan was conducted by the Consortium for Evaluation Research, Training and Service. Through extensive discussions with the Project Director, eight program goals were outlined, and corresponding measurable objectives were developed.

Participants in the program were primarily minority students in three local high schools. During the enrichment phase, students visited several industrial sites and heard presentations by engineers at the University of Michigan. During the academic phase, a small group of students participated in a summer academic program which emphasized mathematics and technical communications skills.

Data for evaluation of the program-wide objectives was drawn from project records and from student surveys. For the summer program, results of a project-developed mathematics test and written essay were analyzed.

Although several of the program's objectives were not met during the first year of operation, many positive outcomes of the program were noted. Success of the summer academic program was indicated by significant increases in the criterion measures. Based upon the data and upon informal discussions and interviews , specific conclusions and recommendations were given.

Section I
INTRODUCTION AND PROGRAM DESCRIPTION

The Engineering Industrial Support Program (EISP) was initiated in October, 1977, at the College of Engineering. Initial support for the program was provided by Ford Motor Company. The general purpose of the program is to assist minority students at the secondary level in preparing for a career in engineering.

Overall Design of the Program

EISP is designed to offer support and assistance to the minority student over a seven-year period. Formal involvement begins during eleventh grade, when the student participates in the enrichment experiences. During the summer between eleventh and twelfth grades, the student participates in the Summer Academic Program. Upon high school graduation, the student is placed in an appropriate summer job.

The program offers continued support through the entire college engineering program. Academic support services are provided by the University, while financial support and continued summer job placements are offered by industry.

The final services of the program are in post-collegiate job placement and follow-up. EISP program personnel will assist graduates in obtaining jobs in the field of engineering and will maintain contact with these former students after beginning the new job.

Program Design for 1977-1978

Phase I. There were three phases in the 1977-78 program. Phase I was a planning phase and extended from inception of the project in September, 1977, until the end of February, 1978. Key events during this phase were:

- Meeting of Ford representatives with College of

Engineering Minority Projects Office to discuss the program design (September 9, 1977).

- Allocation of funds to formally initiate the EISP program (October, 1977).
- Hiring of Derrick Scott as the project director (October, 1977).
- Contacts with administrators, counselors, and teachers in area high schools (January - February, 1978).
- Consent of College of Engineering Department Chairpersons to participate in the program (January, 1978).
- Development of an evaluation design with the assistance of the Consortium for Evaluation Research, Training and Service, the University of Michigan (January - March, 1978).

Phase II. The second phase of the project was the enrichment phase, which extended from March 1 through June 30, 1978. During this period, the program sponsored events of an enrichment or motivational nature for participating students. The purpose of these events was to help students develop an interest in and appreciation of engineering as a potential career field. The enrichment program started with an introductory meeting for interested students and their parents on March 4, 1978, and ended with an Awards Luncheon on June 17, 1978. During the interval between these events, there were eight presentations by College of Engineering faculty members and three field tours. Thus a total of thirteen separate events were held. A listing of these events and corresponding dates is included in Appendix I.

Phase III. The third phase consisted of the Summer Academic Program (SAP), which was held from July 5 to August 30, 1978, at the College of Engineering.

Staff and Organization

The EISP program was administered through the Minority Projects Office of the College of Engineering by Ms. Anne Monterio. Leadership and direction was provided by the Project Director, Mr. Derrick E. Scott. Ms. Rutha L. Moore provided secretarial support.

In each of the three participating high schools, a sponsor was identified to 1) organize and perpetuate the school's engineering club, and 2) serve as a liaison between the program and the students.

The SAP was staffed by two teachers and two assistants for the eight week period. Appendix II contains a complete listing of all people involved in EISP this fall.

Three divisions of Ford Motor Company were involved in the initiation of the EISP program. These divisions were: Climate Control; Electrical and Electronics; and Plastics, Paint and Vinyl. There were several individuals from each division involved in some manner.

Target Students

Target students in the enrichment phase were drawn from Huron HIgh and Pioneer High in Ann Arbor, and from Ypsilanti High in Ypsilanti. The majority of participants in the program were minority students. The numbers of students by school were: Huron, 22; Pioneer, 9; Ypsilanti, 15. To identify students for the enrichment phase, counselors and teachers made referrals to the Project Director. In addition, a presentation (which included a film, slides, and remarks about the program by the Project Director) was held at each school for interested students.

Other participants in the enrichment phase were 22 students from Edmonson Junior High School, Ypsilanti, and 20 students from Willow Run High School. The junior high school students were included so that procedures for working with junior high school students could be tried. The Willow Run High School students were included in some activities as a means of phasing them into the program for 1978-79.

In order to be considered for the Summer Academic Program, interested students returned an application to the Project Director.

Official transcripts, PSAT scores, grade point average and letters of recommendation were also requested. After the selection process was completed, a total of eleven students were included in the Summer Academic Program.

Goals of the Program

During September, October, and the early part of November, 1977, the purpose of the project was carefully scrutinized. During weekly discussion and work sessions, the Project Director and evaluator drafted a set of interrelated goals. After the goals had been clarified, a set of corresponding objectives was developed. For some goals, one objective was prepared. For several others, however, more than one objective was written.

The ultimate societal goal of the project is to help increase the equality of opportunity for minorities in the field of engineering. This general goal would seem to be the implied goal of many programs which are developed with minority students in mind. In practice, this very general goal is rarely stated.

The long-range student goal is to increase the participation of minorities in the field of engineering. Although more concrete than the goal stated previously, this goal cannot be realized within a year. Only after several groups of students have graduated from high school and have had the opportunity to apply for admission to college engineering programs can this goal be assessed.

There are four short-range student goals which could be evaluated within the period which this report covers. Two of these goals address the cognitive (knowledge-related) skills of the students. The remaining two objectives are primarily affective (related to feelings, beliefs, likes and dislikes, etc.).

The last four goals are related to efforts which support the student. For lack of a better term, these goals will be referred to as support goals.

The figure on the following page depicts the relationship among goals in theory. Such a scheme is helpful for understanding and communicating the program intent. Each goal is numbered and corresponds with a goal statement below. By using the figure as a guide, the reader will be able to better understand how the goals and objectives fit into the overall framework of the program. The eight goals are:

1. To help students acquire an appreciation of engineering.
2. To expose students to engineering role models of more than one ethnic background.
3. To help students learn about requirements for entry into a college/school B.S. degree program in engineering.
4. To help students strengthen academic skills.
5. To encourage local industries to participate in minority engineering education programs.
6. To encourage active involvement of high school teachers and counselors in minority engineering education efforts.
7. To facilitate the formation of JETS clubs at target schools.
8. To encourage parent involvement in minority engineering education.

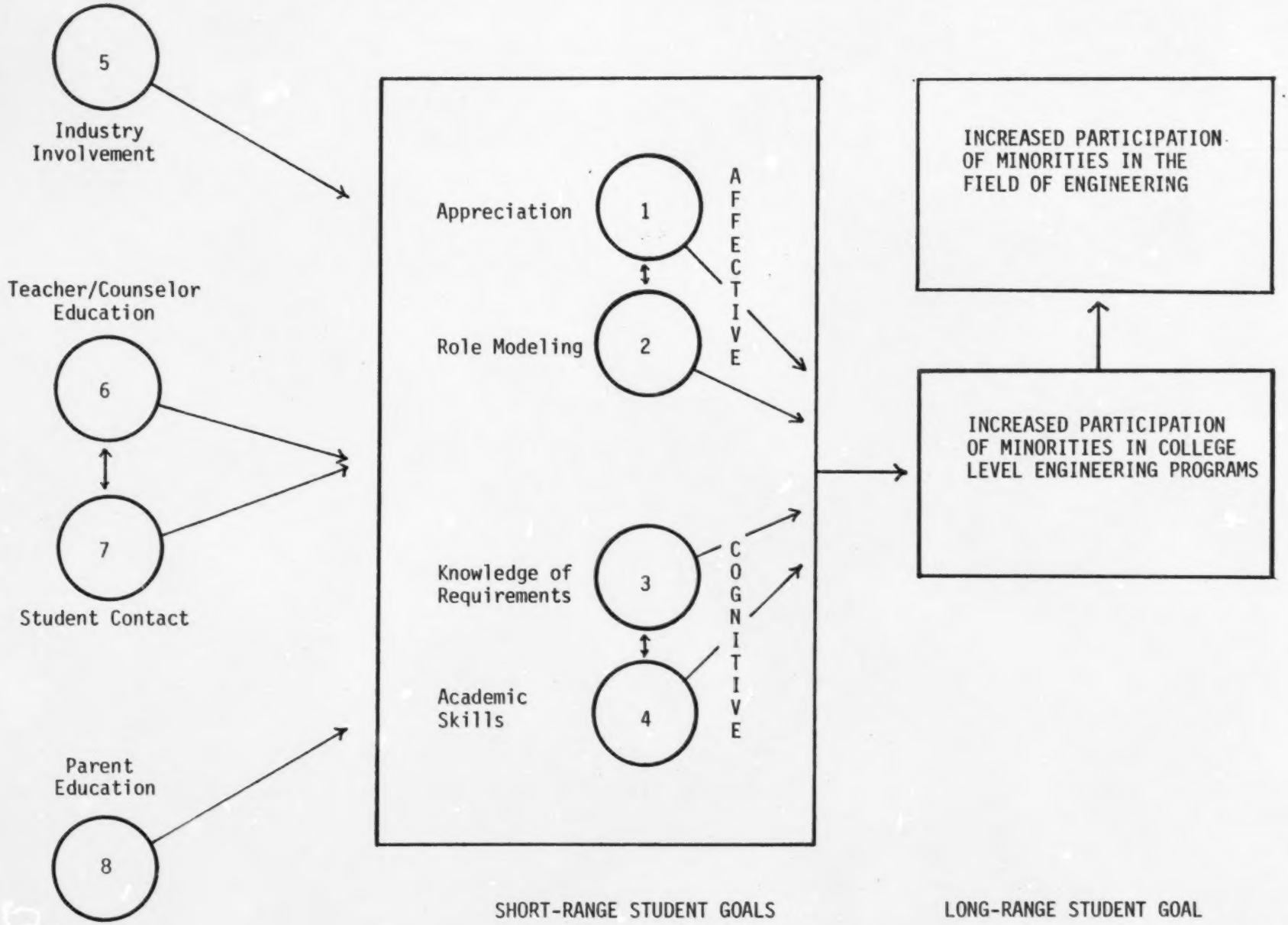

Figure I. Relationships Among Goals of the EISP Program

Section II
PROCESS EVALUATION

During the course of the program, ongoing evaluation was done to help identify problems and suggest solutions while the program was in operation. This was accomplished in two ways. First, consultation services in evaluation were provided on a weekly basis. By discussing problematic developments, the Project Director and evaluator were able to help resolve several important issues (e.g., staffing, program goals and design) before they had a chance to develop into difficulties which would threaten the success of the project. Of course, it was not possible to anticipate every barrier.

On one particular occasion, process evaluation feedback was obtained by interviewing school sponsors during the enrichment phase of the program. Sponsors were asked both very general and very specific questions regarding their role and function in the program. The information obtained from these interviews was used to get a better understanding of the actual activities performed by the sponsors and of their attitudes toward various parts of the program. This information allowed the Project Director to better understand the point of view of the sponsors as well as to begin to plan more effective ways for involving sponsors in the coming program year.

Information gathered through process evaluation efforts is summarized in Appendix IV. Data gathered via questionnaires is tabulated for the use of persons interested in inspecting this information.

Section III
EVALUATION OF THE OBJECTIVES OF THE PROGRAM

In this section, the objective (or objectives) for each of the eight goal areas are individually evaluated. For several objectives the results were somewhat unclear because of lack of data or circumstances which could not be foreseen when the objectives were developed. In cases where an objective was not attained, some attempt was made to explain why it was not met.

Attainment of several objectives was determined from data collected via student questionnaires which were administered before and after the enrichment phase. Thirteen students completed the pretest questionnaire, and twenty-four completed the posttest questionnaire. Since there were just eight students who completed both questionnaires, decisions concerning attainment of objectives were made on the basis of all rather than pre/post matched cases.

Goal 1. TO HELP STUDENTS ACQUIRE AN APPRECIATION OF ENGINEERING

OBJECTIVE	RESULTS
Objective 1.1 80% of the enrichment program student participants will show an increase of one or more points on the Engineering Appreciation Scale after twelve weeks in the program.	1.1 Results for this objective were extremely difficult to determine. First, there were only a total of eight students who took both the pre and post questionnaires. Because of this situation, the objective, as stated, cannot be evaluated. However, analysis of the eight cases was done. The mean pretest Appreciation of Engineering score was 6.45. In comparison, the mean posttest Appreciation of Engineering score was 6.00. These results indicate a slight decrease in appreciation of engineering for these eight students when considered as a group. Individually, there were vast differences in performance. Several students scored so high at the pretest that they reached the ceiling of the scale. Two students showed a marked decrease in appreciation of engineering. From these skimpy data, no generalizations about the program or about all students can be made. However, it would appear that the program may have very different effects upon different students.
Objective 1.2 90% of the student participants will demonstrate a continuing interest in engineering by: A. Attending 90% of the regular JETS Club meetings during the twelve-week period of operation beginning March 4. B. Attending 50% or more of the special engineering events offered at the school and off campus.	1.2 A. This objective was not attained. However, the reason for non-attainment lies in the irregularity of the meetings rather than lack of interest in engineering. During the period being evaluated, some meetings were held at each school. However, at none of the schools were meetings apparently held on a regular (i.e., weekly) basis. B. This objective was met.

Goal 2. TO EXPOSE STUDENTS TO ENGINEERING ROLE MODELS OF MORE THAN ONE ETHNIC BACKGROUND.

OBJECTIVE	RESULTS
Objective 2.1 After completion of the enrichment phase of the program in June, 1978, staff records will indicate that at least one member of each of the following groups participated as role models in the enrichment activities: • Black males • Black females • Spanish surnamed • Native Americans • Puerto Ricans • White males • White females	2.1 This objective was not attained. Engineering role models during the program consisted of the following: black male professionals and college students; black female college students; white male professionals and college students; and white female college students. The apparent reason why the objective could not be attained this year is that the project director did not locate Spanish-surnamed, Native American or Puerto Rican professionals or college students to participate in the program.
Objective 2.2 When asked in June, 1978, 90% of the enrichment participants will respond positively to a set of questionnaire items which measures their perception of the sex/ethnic background of the engineers who participated in the EISP program enrichment activities.	2.2 The portion of this objective pertaining to ethnic identification was attained. 96% of the posttest respondents indicated that the engineers in the program were both minorities and whites. There was no apparent difference between male and female students. Both groups perceived the role models as being of varied ethnic backgrounds. The portion of this objective pertaining to sex of the engineers was not attained. Only 54% of the posttest respondents indicated that the engineers in the program were both males and females. The reason for this may be somewhat obvious. Since students could elect to attend as many or as few enrichment phase events as they desired, it was possible for students to select--by chance alone--only those events in which male engineers participated. This selection factor complicates the evaluation of this objective considerably.

Goal 3. TO HELP STUDENTS LEARN ABOUT REQUIREMENTS FOR ENTRY INTO A COLLEGE/SCHOOL B.S. DEGREE PROGRAM IN ENGINEERING.

OBJECTIVE	RESULT
Objective 3.1 When given a list of 25 high school courses after twelve weeks in the program, 80% of the students will be able to identify a minimum of 8 out of 10 high school courses needed for successful entry into an engineering program at the college level.	3.1 This objective was not met. However, there is evidence that progress toward this objective was made. The results, based upon questionnaire responses of 24 students, are: 62.5% of the students who took the posttest were able to identify 8 out of 10 courses. 75.0% of the students who took the posttest were able to identify 7 out of 10 courses. 92.0% of the students who took the posttest were able to identify 6 out of 10 courses.

Goal 4. TO HELP STUDENTS STRENGTHEN ACADEMIC SKILLS.

OBJECTIVE	RESULT
Objective 4.1 By August 31, 1978, EISP will have conducted a Summer Program for 15 pre-engineering high school students. The adequacy of the Summer Program will be examined in a self-contained evaluation.	4.1 A Summer Academic Program (SAP) of eight weeks' duration was conducted as planned. Because there were fewer qualified applicants than expected, 11 rather than 15 students were admitted into the SAP. The adequacy of the SAP is discussed in detail elsewhere in this report.

Goal 5. TO ENCOURAGE LOCAL INDUSTRIES TO PARTICIPATE IN MINORITY ENGINEERING EDUCATION PROGRAMS.

OBJECTIVE	RESULT
Objective 5.1 By April 1, 1978, a member of the EISP staff will have contacted a representative of the following industrial organizations in person as indicated by the presence of appropriate entries in the staff member's daily log or calendar: • Bechtel • Bendix • Hydramatic • Ford (two plants) • Sycor	5.1 This objective was attained. Contacts with the companies were formal or informal. Informal contacts consisted of conversations in which the industry was not directly asked to participate in the program or to support the program financially. Formal contacts were those conversations in which the industry was clearly invited to participate or to contribute to the success of the program in a significant way. The following table summarizes the contacts for each of the named companies:

Company	Informal Contact	Formal Contact
Bechtel.	X	X
Bendix	X	
Hydramatic	X	
Ford Truck and RV Div. .	X	X
Ford Tractor Division. .	X	X
Sycor.	X	
Chrysler	X	X

Goal 6. TO ENCOURAGE ACTIVE INVOLVEMENT OF HIGH SCHOOL TEACHERS AND COUNSELORS IN MINORITY ENGINEERING EDUCATION EFFORTS.

OBJECTIVE	RESULTS
Objective 6.1. By June 15, 1978, the EISP program staff will have conducted a minimum of two workshops for teachers and/or counselors at the three target high schools as indicated by the attendance sheets and agendas from each session.	6.1 This objective was met. Workshops were not conducted as had been planned earlier in the year. Initial presentations were made to class principals and counselors at all schools on at least one occasion. All three science departments and all but one math department were involved in presentations.

Goal 7. TO FACILITATE THE FORMATION OF JETS CLUBS AT TARGET SCHOOLS.

OBJECTIVE	RESULT
Objective 7.1 By March 31, 1978, the sponsors at each target school will have completed all necessary procedures for establishing a JETS chapter at the school as demonstrated by a copy of the completed JETS chapter application form.	7.1 The objective was not attained this year. Although engineering clubs have been formed at each school, these clubs are not yet JETS chapters. It appears that engineering organizations for students at the three target schools are not yet developed to the point of formalization which JETS memberships would signify. As of May, 1978, one school had established a JETS club.

Goal 8. TO ENCOURAGE PARENT INVOLVEMENT IN MINORITY ENGINEERING EDUCATION.

OBJECTIVE	RESULT
Objective 8.1 By June 15, 1978, the EISP staff will have conducted a minimum of two workshops for parents of students who are involved in EISP-sponsored enrichment activities as indicated by workshop attendance sheets and the presence of planned agendas.	8.1 This objective was not met. The Project Director invested his time in the establishment of engineering clubs and other key features of the program. This objective was not emphasized during 1977-78.

Section IV
EVALUATION OF THE SUMMER ACADEMIC PROGRAM

Introduction

The Engineering Industrial Support Program held an academic enrichment program, from July 5, 1978 to August 30, 1978, at The University of Michigan. The main purpose of the summer academic program was to provide an extensive academic enrichment experience that would assist students, beginning at the secondary school level, in their preparation for pursuing engineering as a career.

Evaluation Questions

The evaluation of the summer academic program was based on the following questions:

1. Has the mean achievement score in mathematics increased significantly over the course of the summer academic program?
2. Have the students increased their technical communication skills significantly over the course of the summer academic program, as measured by scores on a writing sample?

Student Participants

Eleven students were chosen to participate in the Summer Academic Program. Each student was a member of the engineering club at his/her school, and each had just completed his/her junior year at Ann Arbor Pioneer, Huron, or Ypsilanti High Schools.

The demographic characteristics of the class are as follows:

Sex:		Age:	
Male	63.6%	Mean	17.3
Female	36.4%		

Racial:		Grade Point Average:	
Black	72.7%	Mean	3.50
Asian Am.	27.3%		

The program was designed to accommodate fifteen students. Three students applied for SAP and were deemed very capable by the staff. However, these students had a prior commitment for the summer and could not actively participate in the SAP. Since participation in SAP was a prerequisite for continued membership in EISP and it was felt these students would be an asset to the EISP, it was decided to include them in the group and excuse them from the SAP. Therefore, the SAP began with eleven active participants. On August 11, 1978, one of the eleven decided to leave the SAP and was consequently dropped from the entire EISP. Another student decided not to complete the program and therefore has not continued to be involved in the EISP program.

Program Design

The Summer Academic Program consisted of enrichment work in the areas of Mathematics and Technical Communication. The Mathematics course met from 8 to 10 am on Monday, Wednesday and Friday and from 10:30 to 12 noon on Tuesday and Thursday.

The Technical Communication course met from 8 to 10 on Tuesday and Thursday and from 10:30 to 12 noon on Monday, Wednesday, and Friday. Every Friday this class was devoted to library work, and class was held in the University of Michigan Undergraduate Library.

There was one off-campus trip during the SAP. It occurred on July 18, 1978, at the Henry Ford Museum, Greenfield Village, Dearborn, Michigan. The purpose of the fieldtrip was to provide a casual exposure of engineering feats to the students. To meet this end, the students spent the entire morning touring the museum on their own or in small groups.

There were also several on-campus trips during the SAP. The main focus of these trips was toward expanding the awareness of students in the area of electronic computing. Trips to the terminal room of the Undergraduate Library and to the University Computing Center were made.

Staffing

Staffing for the SAP was as follows:

1. Mr. Derrick Scott, Project Director
   Mr. Scott was responsible for the hiring of teaching personnel and the operation of the total SAP.
2. Mr. Curtis Clark, Instructional Aide: Math.
   Mr. Clark is a doctoral candidate at the University of Michigan in the Mathematics Department. He was the main instructor in the math class.
3. Mr. Derwin Jallice, Instructional Assistant: Math.
   Mr. Jallice is a recent graduate of the University of Michigan, majoring in Electrical and Computer Engineering. Mr. Jallice assisted Mr. Clark in the Math program.
4. Ann Stenbeck, Instructional Aide: Technical Communications.
   Ms. Stenbeck is a graduate of the Electrical Engineering Program at the University of Michigan. She was the main instructor for the Technical Communication course from July 5th to August 1st.
5. Eric Fonville, Instructional Aide and Assistant: Technical Communications.
   Mr. Fonville is a Masters student in Civil Engineering. He was an instructional assistant to Ms. Stenbeck, from July 5th to August 1st, and then became the instructional aide on August 1st, for the completion of the course.
6. Lisa Elzy, Instructional Assistant: Technical Communications.
   Ms. Elzy is a senior at The University of Michigan, majoring in English. She was an instructional assistant to Mr. Fonville from August 1 to the completion of the course.
7. Rutha Moore, Project Secretary.

The entire SAP and staff comes under the auspices of the Minority Projects Office, College of Engineering, Anne Monterio, Program Manager.

Technical Communications Course

Objectives and Materials

Objectives of the Technical Communications (TC) course were:
Student participants will develop an awareness of:

1. the different facets of communication skills (reading, writing, observation and listening).
2. the necessity to recognize and utilize in one's communications, the backgrounds and needs of one's audience.
3. the diversity of areas within the field of engineering.

Materials for this course were selected by the instructors according to their ability to meet the above objectives. The materials included articles from newspapers, magazines and journals and some prepared materials from the National Coordinating Center for Curriculum Development.

An integral part of instruction for this course centered around the student's work in the library. Every Friday the students met with Maurita Holland, Head Librarian for the Engineering Library. Ms. Holland set up a library program designed to give students practice in using basic library skills, i.e., finding books and periodicals, using the card catalog, etc.

Observations of the TC Course

Two on-site observations were conducted by the evaluator. On August 10, 1978, the students were observed in activities designed to help them learn to write clear, concise directions. They studied a map of a fictitious high school and then wrote directions on how they would direct a new student from the main door to the principal's office. This was followed with writing directions from the College of Engineering (where the students were at the time) to a well-known landmark in Ann Arbor.

During the second hour, the students moved to another room in the College of Engineering building where video-tape equipment is set up. Each class member presented a three-minute speech which was video-taped. The topic for each speech was a specific type of

engineering. The student described the role and duties of the particular type of engineer being discussed, possible jobs for the engineer, and college courses a student would need in order to become this type of engineer.

During another observation on August 3, 1978, the students discussed an article they had read the previous night. They analyzed it for the appropriate audience, intended message, and other pertinent contents.

Evaluative Data

Students were asked to write an essay at the beginning of the course and another one at the end of the course. These two essays were scored at the end of the course, using the same scoring system for each set of essays. The scores from each set of essays were used as pre-test and post-test data. Table 1 below represents the data from the essays. The table and data are divided according to the subgroupings used by the teacher in evaluating the essays. The summary of grand totals for the essay scoring is shown in Table 2 on the following page.

In analyzing the results of the pre-test and post-test data, it should be noted that the mean increased by three points. This result seems to indicate that a learning gain did occur. However, three limitations in the study ought to be considered when analyzing the data. First, there was an increase of 2.18 in the standard deviation of scores from the pre-test to the post-test. This indicates the variability in scores among the students increased from pre-testing to post-testing. Second, the number of students in this sample (7) is somewhat small. It is difficult to know how bias may have affected the results. Third, there was no available control group against which to compare the results of the experimental group. We have no way of knowing what gains the experimental group of students would have made without the benefits of SAP. Therefore, we cannot make the assertion that

Table 1.

Descriptive Statistics for the Student Essays in Technical Communication

Rating Category	Pretest			Posttest		
	Min/Max Values	Mean	Standard Deviation	Min/Max Values	Mean	Standard Deviation
Power to Generate Ideas	6/8	7.43	0.79	6/8	7.29	0.95
Ability to Focus	3/4	3.86	0.38	3/4	3.86	0.38
Ability to Write Effective Discourse	32/39	35.71	2.69	29/40	36.71	4.42
Eliminating Artificial and Repetitious Language	3/4	3.86	0.38	3/4	3.86	0.38
Imaginative Thinking	6/8	7.71	0.76	6/8	7.71	0.76
Ability to Recognize Methods of Development	2/2	2.00	0.00	2/2	2.00	0.00
Basic Language and Writing Competency	16/23	20.71	2.36	21/24	22.86	1.46

Note: These results are based upon matched cases for 7 students who wrote both the pre and post essays. Data for the remaining students are not available.

Table 2.

Summary Statistics for the Overall Score of the Student Essay

Time of Testing	Range		Mean	Standard Deviation
	Minimum	Maximum		
Pretest	75.000	88.000	81.286	4.4987
Posttest	73.000	90.000	84.286	6.6762

Note: Results are based on seven students who took both the pretest and the posttest.

the gains demonstrated by the students were due to the Summer Academic Program alone.

A paired t-test comparison was conducted to determine if the magnitude of differences in the means was statistically significant. The results of this t-test are shown in Table 3 below. The data indicate that the difference between pre-test and post-test means is statistically significant at the 95% confidence level. This finding is evidence that the difference in means is greater than would be expected by chance alone and supports the contention that the difference is due to the instructional program.

Table 3.
Paired t-test Comparisons

Time of Testing	Mean	Mean Difference	Standard Deviation	t Value	p
Pretest	81.286				
Posttest	84.286	- 3.000	4.0825	-1.9442	.049

Mathematics

Objectives and materials

Objectives of the Mathematics course were:

1. To study the engineering method of problem-solving.
2. To indicate need of mathematical skills in solving problems.
3. To discuss distinction between problems and tools used to solve problems.
4. To learn technique of formulating problems.
5. To familiarize the student with the use of calculators and computers as tools in problem solving.
6. To reinforce mathematical skills through practice exercises.

Some materials for this course came from the National Coordinating Center for Curriculum Development. The following five modules were used by all of the student participants:

a. Fractions
b. Calculators
c. Bridging the Gap
d. Problem Formulation
e. Railroad Crossings

The following texts were also used:

Basic Mathematics for the Physical Sciences. Kruglek, H. and J. Moore, McGraw-Hill Book Co., N. Y., 1963.

Program on Technology and Society. College of Engineering and Applied Sciences, State University of N.Y. at Stony Brook, July, 1977.

Instruction for the course consisted primarily of presentation of problems and discussion, followed by actual solving of practice problems. Supplementary trips to the Computing Center occurred. Computer games, keypunching, building of a circuit system and calculator games were also part of instruction.

Observations

On-site visits by the evaluator were made to observe the course

in progress. The students traveled to the North Campus Computing Center on The University of Michigan Campus to observe the computer first hand on August 8, 1978. There was a tour of the facility to see the hardware and a demonstration of it in operation. The tour was followed by a discussion of computer software and its place in computer operation. The tour was followed by a discussion of computer software and its place in computer operation.

On another occasion, August 9, 1978, problems involving logic and use of venn sets to solve the problems were presented. Two problems were presented with solutions demonstrated by the instructor. Following this, additional problems were presented for the student to solve and discuss.

Evaluative Data

Students were given a diagnostic Math pretest and posttest on July 6, 1978, and August 30, 1978, respectively. The achievement test was developed by the Mathematics instructor for the course. Pre/post mastery tests for each module were also used.

Table 4 below summarizes the data from the pre and post tests.

Table 4.
Mathematics Pretest and Posttest Descriptive Measures.

Time of Testing	Range		Mean	Standard Deviation
	Minimum	Maximum		
Pretest	29.0	42.0	37.22	3.99
Posttest	32.0	47.0	41.78	5.14

Note: Results based on nine students who took both pretest and posttest.

In analyzing the pretest and posttest data, it should be noted that the mean score increased 4.56 points. This increase seems to

indicate that a significant learning gain did occur.

A second analysis of the data was performed, and the results of that test are shown in Table 5 below. The results of the t-test show that the difference between the pretest and posttest is significant beyond the .05 level.

Table 5.

Paired t-test Comparison

Time of testing	Mean	Mean Difference	Standard Deviation	t Value	p
Pretest	37.222	-4.5556	5.4109	-2.5258	.035
Posttest	41.778				

Note: Results are based on nine students who took both pretest and posttest.

Attitude Assessment Survey

On the last day of class, students were given an Attitude Assessment Survey to complete. A copy of this survey can be found in Appendix III, and the tabulated results in Appendix IV.

Section I dealt with the student's feelings about the mechanics of the program. The majority of the students were satisfied with the time constraints of the program. Students also showed a good understanding of the dynamics of the program.

Section II pertained to the student's attitudes about the Mathematics course. A majority of students felt that the instructor did not provide enough feedback on individual progress, but were otherwise pleased with the instructor's performance.

Responses to questions dealing with the Mathematics units were quite varied. While no one unit was singled out by the students, several responses indicated that some units could use revision (i.e., Logic Circuit Work, Calculator Games). Students appeared to be somewhat dissatisfied with the modules for the course.

Students responded to the Technical Communications course in Section III. They felt the instructor's ability to provide feedback on individual progress was one weakness. Responses for the units in the course were quite varied here also. Revising the activities in some units may alleviate some of the variance in the responses.

Section IV dealt with overall feelings about the program and the benefits that may have accrued from participating in the program. A majority of students felt the program was a benefit to them academically as well as by providing additional information about engineering.

Conclusions

It is concluded that the SAP was generally successful in meeting its goals. The data indicate that the students made significant progress in Mathematics and Technical Communications over the course of the program.

Although several problems did arise during the program, they appeared to be handled appropriately. These were problems which could not have been easily anticipated before starting. More extensive planning would probably not have helped forestall the problems which finally did surface.

The Project Director took positive steps to correct program deficiencies while the program was in progress. He demonstrated effective leadership skills and monitored the progress of students in several ways. He was sensitive to the needs of individual students as well as to the needs of the overall program.

Recommendations

1. More attention should be given to the selection of math and communications materials. Students need to see the relevance of the material while it is interesting enough to capture their attention.
2. More attention should be given to communicating the benefits of the EISP to the students. This would serve to give the students a better understanding of the program and maintaining a high motivational level to remain in the program.
3. In selecting students for the SAP, extra time should be devoted to impressing upon them the importance of continued participation in SAP and the necessity of such in order to continue in EISP.
4. More fieldtrips ought to be considered. While the academics of the program are recognized as being very important, it is felt that a more active look at the role of an engineer would be of interest to the students.
5. Restructure the fieldtrip to the Henry Ford Museum. It is felt a more organized tour of the museum with specific attention given to projects of major importance would be more beneficial.

Section V
CONCLUSIONS AND RECOMMENDATIONS

The following list of conclusions and recommendations is based upon both formal and informal evaluation procedures. Recommendations are based upon conversations with various project personnel as well as with sponsors and students.

Conclusions

1. Program planning and management were appropriate and adequate. There were no instances of lack of leadership known to the evaluator.

2. Although several staffing changes created problems before and during the SAP, scores on the essays and mathematics tests increased significantly over the 8-week period. Results of the student survey indicate that students felt that they benefitted from the SAP.

3. Of the 11 objectives of the EISP program, five were met; five objectives were not met; and the attainment of the remaining objective was unclear. For many of the unmet objectives, there was good evidence of progress toward attainment.

Table 6
Summary of Attainment
of 11 EISP Objectives

Objective Number	Status: Attained	Status: Not Attained	Status: Attainment Not Evaluable
1.1			X
1.2.A		X	
1.2.B	X		
2.1		X	
2.2	X		
3.1		X	
4.1	X		
5.1	X		
6.1	X		
7.1		X	
8.1		X	

Recommendations

1. Some criteria for inclusion of schools in the program should be developed. These criteria should spell out what needs to be done by the school administrator and by the staff in order that program resources be maintained at the school. If minimal criteria are not met at a particular school, resources should be transferred from that school to one where more students will benefit. If it becomes necessary to withdraw program support from a school, those students who are already committed to the program should not be excluded from the program.

2. "Hands-on" engineering projects should be encouraged during all phases of the EISP program. Perhaps there is a way for each student to develop his/her ideas and motivation by working upon

an independent project during the school year. The project may serve many functions and help draw together students and teachers. A competition (engineering fair) at the end of the school year would help students in technical communication as well as serve an important motivating function.

3. A source book or guide for school sponsors would be helpful for planning activities and events for engineering clubs.

4. Careful consideration needs to be given to the process for identifying school sponsors. It would appear that the ability to work well with students may be more important than a background in engineering. The school sponsor is a critical person in regards to real success of the program.

5. Specific expectations for the teaching staff should be spelled out in detail before the beginning of the SAP next year. A follow up by the project director to determine if expectations are being met should occur no later than the third week of the SAP.

6. The goals and objectives of EISP should be further refined during October, 1978. The present goals appear to be appropriate. Some of the objectives, however, may need to be revised in order to correspond to the method of measurement used in the coming year.

7. Although it is important to assess short-range goals, some provisions need to be made this year so that evaluation of the long-range goals can be started. Such preparations would include (at a minimum) maintaing a complete and accurate list of students in the program this year so that their efforts in applying for entrance in a B.S. engineering program can be followed up.

8. Some consideration to <u>possible</u> negative effects of the program upon student motivation should be explored. The evaluator and

project director may find it helpful to gain information directly from students about this.

9. Student information should be obtained through personal interviews rather than by questionnaires alone. The rationale for this change is based upon the low rate of questionnaire return and the very low number of matched cases on pre/post information. Personal interviews at a pre-scheduled time would help to reduce this problem. Although this method of collecting information is more costly, it yields much better quality information.

10. A writing sample of an essay nature should again be used to evaluate the outcomes of the technical communication section of the SAP. However, the objectives of the technical communication need to be further refined well before the SAP. After refinement of the objectives, a new system for coding student essays needs to be developed in accordance with the objectives of the section.

11. Videotaped presentations by students at the end of the SAP should be utilized for program evaluation purposes. A checklist which includes specific desirable behaviors should be used by evaluation personnel to rate each participant's end-of-course attainment.

12. It is recommended that Goal 7 be either revised or eliminated from the program. Although it is very desirable to have engineering clubs at each school, it does not seem necessary that the clubs be affiliated with the Junior Engineering Technical Society.